CHAPTER 6. DIGITAL IMAGING AND THE DIGITAL IMAGING COMMUNICATION IN MEDICINE (DICOM) STANDARD

6-1. INTRODUCTION

a. Digital imaging has streamlined processes within the radiology department. Most of the tasks related to film production, transcription, and filing have been eliminated and replaced with the acquisition and storage of data on-line. To support digital imaging and the re-engineering of the radiology department, all new purchases and upgrades will support the DICOM 3.0 standard. All diagnostic imaging modalities will ultimately conform to DICOM standards. Currently, focused purchases of DICOM-conformant systems will facilitate the integration of acquisition devices to a Hospital or Radiology Information System (HIS/RIS), an image management system, or a PACS.

b. The ACR and the National Electrical Manufacturers Association (NEMA) jointly developed the DICOM Standard to facilitate interoperability of medical imaging equipment, regardless of the device manufacturer. The DICOM standard facilitates interoperability of medical imaging equipment by specifying the protocols to be followed by devices claiming conformance to the standard and the syntax and semantics of the information exchanged using these protocols. The DICOM standard supports operation in a networked environment using industry standard networking protocols such as transmission control protocol/internet protocol (TCP/IP). Provision of the applicable DICOM service object pairs (SOP) classes is ultimately required for integration with a PACS.

c. Two sets of specifications follow: a subset of the DICOM standard that is required to provide basic functionality and a set of specifications that is not required but highly recommended to accommodate workflow and data integrity.

6-2. REQUIRED SERVICE OBJECT PAIRS FROM THE DICOM STANDARD

a. The DICOM standard relates an object (image) to a service (action) to be performed on that object. These relationships are defined within the DICOM standard as SOP. To exchange image data, each modality should support the DICOM 3.0 image storage SOP class for that modality as shown in Table 6-1, e.g., a computed tomography (CT) should comply with the CT image storage SOP class, ultrasound with the ultrasound SOP class, etc. To send or receive DICOM objects such as images, support to a DICOM SOP class can be as a service class user (SCU), a service class provider (SCP), or both. At a minimum, the modality must support the image storage SOP class as an SCU.

b. Besides conforming to the individual modality image storage SOP classes, all acquisition devices should support the DICOM 3.0 verification, query/retrieve, modality performed procedure step, modality worklist management, and the print management SOP classes (Table 6-1). In addition, for CT and MR and possible other future modalities, query/retrieve should be supported.

c. DICOM verification allows one DICOM-conformant system to "ping" or request a communication transaction with another DICOM-conformant system and verify that the systems can talk to each other.

d. DICOM query/retrieve conformance allows the a modality-specific post-processing workstation to interactively retrieve images from other acquisition or storage devices, soft-copy display workstations, teleradiology spokes/hubs, and other PACS. Query/retrieve conformance is not required for devices intended to function solely as a modality operator console, except for CT, MR, and possibly digital mammography.

e. The modality performed procedure step SOP class allows a modality to inform the PACS and the modality worklist manager that an exam has been completed.

f. Conformance to the modality worklist information model find SOP class as an SCU allows patient demographic and scheduling data from the RIS/HIS to be retrieved from an acquisition modality console and also allows the technologist to select the patient information from a "pick list" or using an accession number or patient ID, rather than retyping the patient information. This capability enhances the efficiency and overall productivity of the technologist and reduces errors in patient demographic data that might result in exams that cannot be matched with the original order or other study components. The result should improve workflow and efficiency because data errors typically have to be corrected by a PACS system administrator.

g. DICOM print management conformance facilitates networking of image printers using standardized protocols. This should eliminate the added expense of procuring individual interfaces for each acquisition device and printer.

6-3. RECOMMENDED SERVICE OBJECT PAIRS FROM THE DICOM STANDARD

a. It is desirable that, in addition to the requirements listed in Table 6-1, the modality provides conformance to other DICOM 3.0 SOP classes.

b. The storage commitment push model SOP class ensures safe storage of the image data by the PACS before the data is deleted from local storage at the acquisition device (modality). This ability is important when sending images to a remote location, because the sender can rely on the receiver to take responsibility for the data.

c. Grayscale softcopy presentation state SOP class allows a modality to specify the intended image presentation state of the exam.

d. Grayscale display and print SOP classes will allow all display stations and all printers that support the associated SOP class to reproduce that image with uniform grayscale. Thus, all images will look that same regardless of where they are reproduced.

e. The basic annotation box and image overlay box SOP classes allow text and graphic annotations to be appended to the image data set without permanently overwriting the original image data. These SOP classes also provide a mechanism to output pertinent demographic, management, and graphic information to hard copy print devices without overwriting the original image data.

f. It is also highly desirable that the acquisition devices provide removable media, conforming to the DICOM media exchange application profiles as specified for that modality (e.g., CT or MR, x-ray angiography, ultrasound, or general purpose radiography) using CD-R or magneto-optical disk to allow file exchange between workstations/facilities and to support failover operations in the event the network or PACS is down.

Table 6-1. REQUIRED MODALITY DICOM SERVICE OBJECT PAIR CLASSES

SOP Class Name	SOP Class UID	Role
MR Image Storage	1.2.840.10008.5.1.4.1.1.4	SCU
CT Image Storage	1.2.840.10008.5.1.4.1.1.2	SCU
Computed Radiography Image Storage (Note 1)	1.2.840.10008.5.1.4.1.1.1	SCU
Nuclear Medicine Image Storage	1.2.840.10008.5.1.4.1.1.20	SCU
Secondary Capture Image Storage (Note 2)	1.2.840.10008.5.1.4.1.1.7	SCU
Ultrasound Multiframe Image Storage	1.2.840.10008.5.1.4.1.1.3.1	SCU
Ultrasound Image Storage	1.2.840.10008.5.1.4.1.1.6.1	SCU
X-Ray Angiographic Image Storage	1.2.840.10008.5.1.4.1.1.12.1	SCU
X-Ray Radiofluoroscopic Image Storage	1.2.840.10008.5.1.4.1.1.12.2	SCU
Digital X-Ray Image Storage - For Presentation (DR)	1.2.840.10008.5.1.4.1.1.1.1	SCU
Positron Emission Tomography Image Storage	1.2.840.10008.5.1.4.1.1.128	SCU
Digital Mammography Image Storage – For Presentation	1.2.840.10008.5.1.4.1.1.1.2	SCU
Digital Intra-oral X-Ray Image Storage – For Presentation	1.2.840.10008.5.1.4.1.1.1.3	SCU
Mammography CAD SR	1.2.940.10008.5.1.4.1.1.88.50	SCU
Verification	1.2.840.10008.1.1	SCU/SCP
Patient Root Query/ Retrieve Information model-FIND (Note 3)	1.2.840.10008.5.1.4.1.2.1.1	SCU/SCP
Patient Root Query/ Retrieve Information model-MOVE (Note 3)	1.2.840.10008.5.1.4.1.2.1.2	SCU/SCP
Study Root Query/ Retrieve Information model-FIND (Note 3)	1.2.840.10008.5.1.4.1.2.2.1	SCU/SCP
Study Root Query/ Retrieve Information model-MOVE (Note 3)	1.2.840.10008.5.1.4.1.2.2.2	SCU/SCP

(continued) Table 6-1. Required Modality DICOM Service Object Pair Classes

SOP Class Name	SOP Class UID	Role
Modality Performed Procedure Step	1.2.840.10008.3.1.2.3.3	SCU
Modality Worklist Information Model-FIND	1.2.840.10008.5.1.4.31	SCU
Basic Grayscale Print Management Meta SOP Class	1.2.840.10008.5.1.1.9	SCU
Basic Color Print Management Meta SOP Class	1.2.840.10008.5.1.1.18	SCU

Note 1: As an alternative, computed radiography devices can support digital x-ray image storage - for presentation SOP class

Note 2: Secondary capture image storage is required for x-ray film digitizers and any devices which capture and convert print output from legacy modalities to provide a DICOM interface.

Note 3: Query/retrieve is required for modality-specific post-processing workstations, but is not required for devices intended to function solely as an operator console. It may be desired for the operator consoles of certain modalities, such as CT or MRI, where the operator may wish to have specific knowledge of the images acquired in a previous study.

6-4. OBJECT IS IMPROVED ACCESS TO RADIOLOGY

The object is to support business process changes throughout the MHS, especially within the practice of military radiology. The vision for radiology is to create a seamless radiology department by eliminating the constraints that may be created by having multiple places where diagnostic imaging is conducted within and between Army and other DOD MTFs.